Development of and Emissions Impacts of More Stringent ASM Cutpoints in the California Smog Check Program

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Introduction

- Goal: Development of more stringent cutpoints that maximize identification of vehicles with significant emission control system defects while minimizing false failures.
- The ASM test measures emissions at two speed-load points.
- How can we improve our confidence that more stringent ASM cutpoints will identify defects that result in elevated emissions over a broader range of driving conditions?

General Approach

- Compare ASM failure rates in CA to failure rates in states running transient tests (IM147 and IM240).
- Vehicles with high ASM failure rates compared to IM147/IM240 should be left alone.
- Vehicles with low ASM failure rates compared to IM147/IM240 are candidates for more stringent ASM cutpoints.

“Vehicle Specific” Cutpoints

- Failures rates in CA were compared to failure rates in AZ (IM147) and WI (IM240) based on the following:

  - Model Year (pre-1996 only)
  - Manufacturer (e.g., GM, Toyota)
  - Make (e.g., Chevrolet, Lexus)
  - Model (e.g., Caprice, Camry)
  - Engine Displacement
  - Number of Cylinders
  - Transmission Type

- For cases in which sample size was small (< 50), data were aggregated (e.g., Dodge Aries and Dodge Shadow would be combined if both were equipped with 4-cylinder, 2.2 liter engine and automatic transmission).

“Vehicle Specific” Failure Rates
(1992 - 3.1L - 6Cyl - AT - Pontiac)

- Vehicle-specific failure rates in each program were first compared to the model year average.
- In this example, failure rates are lower than average in CA; higher than average in AZ/WI:

Program	Vehicle Failure Rate	MYR Failure Rate	Normalized Failure Rate
California	10.7%	18.9%	0.57
Arizona	26.7%	15.7%	1.70
Wisconsin	23.0%	18.9%	1.22

“Relative Failure Ratios”
(1992 - 3.1L - 6Cyl - AT - Pontiac)

- The normalized failure rates from CA were then divided by the normalized failure rates from AZ/WI to develop “relative failure ratios” (RFRs).
- Vehicle groups with low RFRs are candidates for tighter cutpoints; vehicles with high RFRs are left alone.
- The RFRs for this vehicle group are:

$$RFR_{AZ+WI} = 0.57/((1.70+1.22)/2) = 0.4$$
$$RFR_{AZ} = 0.57/1.70 = 0.3$$
$$RFR_{WI} = 0.57/1.22 = 0.5$$

Candidates for More Stringent ASM Cutpoints
(1992 Model Year)

Make	Disp	Cyl	Trans	CA Failure Rate (%)	AZ Failure Rate (%)	WI Failure Rate (%)	Relative Failure Ratios vs AZ+WI	vs AZ	vs WI
All Vehicles	All	All	All	18.9	15.7	18.9	--	--	--
CHRYSLER	3.8	V6	A	3.2	9.7	20.4	0.2	0.3	0.2
BUICK	3.1	V6	A	6.1	23.4	20.2	0.3	0.2	0.3
OLDSMOBILE	3.1	V6	A	7.4	29.4	22.2	0.3	0.2	0.3
CHRYSLER	3.0	V6	A	5.4	16.2	17.2	0.3	0.3	0.3
MERCURY	2.3	L4	A	2.5	5.7	9.5	0.3	0.4	0.3
SUBARU	1.8	H4	A	2.6	13.8	0.0	0.3	0.2	>>1
FORD/MAZDA	2.2	L4	A	2.4	8.1	5.4	0.3	0.2	0.4
CHEVROLET	3.1	V6	A	8.1	25.7	20.9	0.3	0.3	0.4
INFINITI	4.5	V8	A	3.9	13.4	8.8	0.3	0.2	0.4
CHRYSLER	3.3	V6	A	7.1	11.5	26.1	0.4	0.5	0.3
PLYMOUTH	2.5	L4	A	15.5	34.1	41.1	0.4	0.4	0.4
PONTIAC	3.1	V6	A	10.7	26.7	23.0	0.4	0.3	0.5
DODGE	2.5	L4	A	16.3	37.0	39.0	0.4	0.4	0.4
FORD	2.3	L4	A	3.5	7.6	7.2	0.4	0.4	0.5
FORD/MAZDA	3.0	V6	A	4.4	6.3	10.2	0.5	0.6	0.4
PONTIAC	5.0	V8	A	13.8	24.0	25.9	0.5	0.5	0.5

Passing Vehicle ASM Emissions Were Also Used to Assess Potential for Cutpoint Changes

- Fast-pass algorithm makes a direct examination of passing vehicle emissions problematic.
- Passing vehicle ASM scores (as a fraction of the current cutpoint) were split up into four separate groups, or quartiles, and the cleanest 25% were analyzed.
- A low Q1 score (e.g., 15% of the cutpoint) suggests properly functioning vehicles easily meet current cutpoints.
- A high Q1 score (e.g., 60% of the cutpoint) suggests the cleaner vehicles in the group are struggling to meet current cutpoints.

Cutpoint Scenarios

- Three cutpoint scenarios were evaluated:
  - Scenario 1 = RFR ≤ 1.5 and Q1 Score < 0.5
  - Scenario 2 = RFR ≤ 1.25 and Q1 Score < 0.5
  - Scenario 3 = RFR ≤ 1.0 and Q1 Score < 0.5
- A maximum reduction of 30% in cutpoint level was established based on a review of the CCR.
- Revised cutpoints were calculated as follows (by pollutant and test mode):

$$\text{Revised CP} = \text{Current CP} \times \max(Q1/0.5,\ 0.7)$$

Concern: Use of Non-CA Data

- Concern has been expressed that differing emissions standards between CA and AZ/WI may impact results.
- While it is true that some vehicle groups may have been certified to slightly different standards, this should have minimal impact on the analysis because:
  - Many of the vehicles in this timeframe (pre-1996 MY) were equipped with “50-state” engine families.
  - The age of the vehicles analyzed make vehicle “migration” more likely (for both CA and non-CA fleets).
  - The analysis was based on relative failure rates, which mitigates differences in standards.

Concern: Marginal Emitters are Targeted

- Concern has been expressed that tighter standards only capture marginal emitters.
- This is true in some cases, but the approach used in this analysis was intended to identify a subset of vehicles that pass current ASM cutpoints but fail during transient testing.
- Based on an analysis of ARB surveillance data, the vehicle-specific cutpoints successfully identified additional high-emitters (see next slide).

Vehicles in ARB Surveillance Data Set that
Passed Current ASM Cutpoints but Failed Vehicle-Specific Cutpoints

Model Year	Make	Model	Cyl	Disp	Trans	Fail with RFR: <1.5	<1.25	<1.0	Multiple of FTP Standard HC	CO	NOx
1978	CHEVROLET	Caprice Classic	8	5.0	A	1			3.2	1.1	1.3
1981	CHEVROLET	G2500 Van 2WD	8	5.0	A	1	1		3.2	4.4	1.7
1983	GMC	G2500 Van 2WD	8	5.0	A	1	1	1	2.9	0.7	1.5
1984	BUICK	Skylark Custom	6	2.8	A	1			1.1	0.2	2.1
1984	CHRYSLER	New Yorker	4	2.2	A	1	1	1	1.2	1.2	1.5
1985	HONDA	Accord	4	1.8	M	1	1		10.8	12.8	0.3
1986	TOYOTA	Celica	4	2.0	A	1	1		3.0	2.9	1.3
1987	NISSAN	Sentra	4	1.6	A	1	1		3.3	3.2	1.1
1988	TOYOTA	Camry	4	2.0	A	1	1		0.6	0.3	1.2
1990	DODGE	Caravan	6	3.3	A	1	1	1	1.9	0.9	1.3
1990	FORD	F150 Regular Cab	8	5.0	A	1	1	1	2.9	3.8	0.9
1990	HONDA	Accord	4	2.2	M	1	1	1	0.8	0.9	1.5
1990	PLYMOUTH	Voyager	6	3.0	A	1	1	1	1.1	0.8	1.4
1990	TOYOTA	Corolla	4	1.6	A	1			0.6	0.2	1.3
1991	FORD	Explorer XL 4WD	6	4.0	A	1	1		1.0	1.0	1.6
1991	FORD	Taurus L	6	3.0	A	1	1		1.2	0.7	2.9
1991	HONDA	Accord	4	2.2	M	1	1	1	1.3	1.6	2.2
1991	INFINITI	G20	4	2.0	A	1			1.0	0.8	1.1
1991	TOYOTA	Camry	4	2.0	A	1	1	1	0.4	0.3	0.9
1992	PONTIAC	Grand Am LE	6	3.3	A	1	1		0.8	0.6	2.4
1993	CHEVROLET	C1500 Pickup 2WD	6	4.3	A	1			1.9	2.8	2.9
1993	CHEVROLET	Lumina	6	3.1	A	1	1	1	3.1	2.3	1.6
1993	MITSUBISHI	Eclipse	4	1.8	A	1	1		1.5	0.5	2.3
1994	HONDA	Accord	4	2.2	M	1	1		1.2	1.4	1.2
1994	NISSAN	Pathfinder	6	3.0	A	1	1	1	1.0	0.9	0.7

Impact on Smog Check Failure Rates

- Roadside data (full duration ASMs) were used to establish a ratio of failure rates under revised and current cutpoints.
- Those ratios were applied to Smog Check failure rates to estimate the impact of the revised cutpoints.
- Resulting failure rates (April to June 2004 data):
  - Current Cutpoints: 10.4%
  - Scenario 1: 12.8%
  - Scenario 2: 12.4%
  - Scenario 3: 11.9%

Impact on Statewide Emissions
(Tons per Day in CY2010 in Enhanced Areas)

Before/after-repair FTP/ASM data from ARB were used in conjunction with EMFAC2002 to estimate statewide emissions benefits of more stringent cutpoints.

Scenario	ROG	NOx	ROG+NOx
Scenario 1	2.7	5.1	7.8
Scenario 2	2.6	4.8	7.4
Scenario 3	2.0	3.5	5.5